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J. Michael Neary — Jan. 7, 2003
J. Michael Neary — Date

Inventor:	Gabrys and Simmons	)
		)Group Art Unit: 3682
Serial No.:	09/630,157	)
		)Examiner: Chong H. Kim
Filed:	July 31, 2000	)
		)
Title:	"Flywheel Hub-to-Rim Coupling"	

Brief on Appeal

January 7, 2003

Commissioner for Patents
Washington, D. C. 20231

Sir:

This Brief on Appeal is being submitted in furtherance of Applicant's appeal from the final rejection of claims 1-8 and 10-20 in the Final Office Action dated June 7, 2002.

1) Real party in interest

Toray Composites, America, Inc., assignee of this Application, is the real party in interest.

2) Related Appeals and Interferences

Applicant knows of no related interferences or appeals that would directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

3) Status of Claims

Claims 1-8 and 10-20 were rejected in the Final Office Action as noted in summary fashion below. No claims have been allowed.

A. Claims 1-8 and 10-20 have been rejected under 35 USC 112, 1st ¶, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

B. Claims 7, 8 and 10-20 have been rejected under 35 USC 112, 2nd ¶, as indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as their invention was proper.

C. Claims 7 and 8 were rejected under 35 USC 102 as anticipated by Kundermann.

4) Status of Amendments

On October, 7, 2002, an amendment after final rejection was submitted under Rule 116. An affidavit was attached to the R116 amendment to provide evidence, as requested by the Examiner in the Final Office Action, to explain how the disclosure was sufficient to a person of ordinary skill in the art to make and use the invention. The amendment also amended claim 7 to add subject matter from claim 3, which had been rejected only under the §112 rejection, which was explained and (Applicants believe) overcome by the affidavit. Some other claims were also amended, in accordance with the Examiner's suggestions, to correct other informalities and resolve the §112 grounds on which they had been rejected.

On Oct. 30, 2002, the Examiner refused entry of this R116 amendment on the ground that it "raised new issues that would require further consideration and/or search" and did not place the application in better form for consideration and/or search by materially reducing or simplifying the issues for appeal.

On Nov. 7, 2002, Applicants filed a Notice of Appeal and also a Request for Reconsideration of the refusal to admit their R116 amendment, explaining that the added subject matter had already been searched and how the proposed amendment actually greatly simplified the application for consideration of this appeal.

On Dec. 6, 2002, the Examiner's supervisor issued an Advisory Action refusing entry of the R116 amendment on the ground that the previously searched subject matter had not been considered in the context of claim 7.

On Jan 2, 2003, Applicants submitted a Petition under Rule 181 for entry of the Rule 116 amendment. A decision on that petition is still pending.

An amendment is being submitted with this Appeal Brief to present all the amendments proposed for the §112 rejected claims in the R116 amendment, and with the Affidavit offered with the R116, but without the proposed amendment to claim 7 (specifying that the rim liner is inside the rim), which was the only ground stated by the Examiner for refusing entry of the R116 amendment. If the Petition for entry of the R116 Amendment is granted, Applicants will submit a revised and greatly simplified appeal brief to present arguments for the patentability of the claims as amended.

5) Summary of the Invention

The invention provides a flywheel system having a composite flywheel rim that allows use of low modulus, low cost fiber that has high radial growth of the inside diameter of the rim. A rim liner inside the flywheel rim provides half of a sliding joint with the hub, which drives and is driven by the flywheel rim. The rim liner contains either holes for radial pins that match pin holes on the hub periphery or spline teeth that mate with teeth on the hub periphery. The flywheel rim liner is made of a material having a ratio R_l equal to E/ρ, where E is the modulus of elasticity in the hoop direction, and ρ is the material density. The ratio R_l of the rim liner material is less than or equal to the corresponding ratio R_r of the rim material, so the flywheel rim liner grows radially with the rim and remains in compressive contact therewith.

6) Issues

A. Whether the rejection of claims 1-8 and 10-20 under 35 USC 112 as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention was proper.

B. Whether the rejection of claims 7, 8 and 10-20 under 35 USC 112, 2nd ¶, as indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as their invention was proper.

C. Whether the rejection of claims 7 and 8 under 35 USC 102 as anticipated by Kundermann was proper.

7) Grouping of Claims

The rejected claims do not stand or fall together; that is, claims 1-8 and 10-20 are separately patentable, as explained in detail in the following Argument.

8) Argument

For simplicity of relating the summary Status of the Claims in §3 and the Statement of Issues in §6 with the related argument in this §8, the same letters used in §§3 and 6 will identify the argument sections.

A) Claims 1-8 and 10-20 have been rejected under 35 USC 112 as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Claim 1 calls for a flywheel system having a flywheel rim and a concentric flywheel hub with a radially slotted exterior surface facing radially outwards. An annular flywheel rim liner, coaxial with the hub, has an inner surface facing radially inward toward the hub. The inner surface of the rim liner has radial projections that mate with the hub slots to form a torque transmitting coupling therebetween that maintains concentricity

between the hub and the rim liner while allowing the rim liner to grow radially with respect to the hub.

The heart of the §112 rejection of claim 1 is reproduced below:

> Claims throughout recite the limitation wherein the rim liner grows radially with the rim. This growth is attributed by the specific characteristics of each material the rim and the rim liner utilize. Although the formulas for calculating the numerical values to compare each other are provided, the variables dealing with the characteristics of each material used are not provided in the specification. Without the exact composition of the material and its values such as modulus of elasticity or the density, making of the invention is very difficult to carry out.

In the paragraph 7 of the Final Office Action, the Examiner invited Applicants to shown that know-how exists, without extensive research by the manufacturing industry, to follow the teachings in the specification to produce the claimed invention. In response, Applicants submitted an Affidavit by co-inventor Dennis Simmons explaining in detail how basic information available from manufacturers of materials or from the open literature is applied, using simple calculations also available in the open literature, to apply the teachings of the specification to make the claimed invention. Applicants were confident that this affidavit resolved the §112 rejection. However the R116 amendment was not entered, nor was the Simmons affidavit even though the grounds for refusing entry had nothing to do with the affidavit.

The Simmons affidavit, with Exhibit A, is resubmitted with this Appeal Brief. The affidavit illustrates and explains the information that is available from suppliers and the open literature about the characteristics of materials used in modern flywheels, and shows how that information is applied in accordance with the teaching in the specification to make the invention. Specifically, the affidavit illustrates an example of the data that is available from suppliers about the materials they sell, and other open literature sources, and shows how that data is used to make the simple calculations to ensure that the rim liner always remains in compressive contact with the rim.

B. Claims 7, 8 and 10-20 have been rejected under 35 USC 112, 2nd ¶, as indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as their invention was proper. The insufficient antecedent basis for "said rim" in claim 7 is corrected in the proposed amendment accompanying

this appeal brief. The terms "maximum speed" and "high speed" in claims 10, 13, 15 and 18 have been deleted as suggested by the Examiner to remove the grounds for the §112 rejection of claims 7, 8 and 10-20 based on his opinion that they were "relative terms" and made the claims indefinite. .

C. Claims 7 and 8 were rejected under 35 USC 102 as anticipated by Kundermann. Applicants believe that their non-entered R116 amendment to claim 7 would have removed any question about the patentability of claim 7, but the issue of whether that amendment presents new issues (the line liner is inside the rim) and would require further consideration or search is pending in Applicants' Petition under R181, so the argument will now be made for patentability of claim 7 without that added limitation.

Claim 7, amended to correct the §112 informalities, calls for a flywheel system having a flywheel hub, a flywheel rim, and a rim liner in compressive contact with the rim. The flywheel hub has radial splines, and flywheel rim liner has radial projections mating with the splines on the hub to form a torque transmitting coupling between the hub and the liner that maintains concentricity between the hub and the rim liner. The flywheel rim liner is made of a material having a strain-to-failure capability and a ratio R_l equal to E_l/ρ_l, wherein E_l is a hoop modulus of elasticity of the rim liner and ρ_l is the density of the rim liner material. The rim liner strain-to-failure capability and ratio R_l are such that the rim liner remains in compressive contact with the rim throughout operation of the flywheel system.

Kundermann teaches a coupling device between a drive shaft and the flywheel mass in the torque converter of an automobile. A series of radial spring fingers on a drive disc attached to the drive shaft have radial teeth that engage slots in a ring on the flywheel. The compliance of the radial spring fingers allows the drive shaft to remain engaged with the flywheel despite perturbations in the torque or vibration between the parts, thereby eliminating chatter.

Kundermann does not mention the problem of differential radial growth due to centrifugal force, and it is not a problem that would ever occur in an automobile because of the low rotational speed in automobile engines.

Kundermann has a flywheel mass 31 which, when one attempts to read claim 7 on it, corresponds to the flywheel rim of claim 7. Kundermann has a "hub" 23 bolted to the drive shaft 1. Now it is necessary to find a "rim liner" in compressive contact with the rim and having radial projections mating with the splines on the hub to form a torque transmitting coupling between the hub and the liner to maintain concentricity between the hub and the rim liner, and made of a material having a strain-to-failure capability and a ratio R_l equal to E_l/ρ_l, wherein E_l is a hoop modulus of elasticity of the rim liner and ρ_l is the density of the rim liner material such that the rim liner strain-to-failure capability and ratio R_l maintain the rim liner in compressive contact with the rim throughout operation of the flywheel system. No such rim line exists in Kundermann, so there is no correspondence between Kundermann's disclosure and claim 7. Accordingly, claim 7 and its dependent claim 8 should be allowable over Kundermann.

Thus, Applicant believes that the claims now pending in this application are patentable over the cited prior art and are allowable in their present form. Applicant respectfully requests that the Examiner's final rejection be reversed and that this application be remanded to the Examiner for allowance.

Respectfully submitted,

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9) Appendix

1. A flywheel system, comprising

a flywheel hub having an axis of rotation and a radially slotted exterior surface facing radially outwards;

an annular rim liner having an axis of rotation coinciding with said hub axis of rotation, and having an inner surface facing radially inward, said inner surface having radial projections on said rim liner that mate with said hub slots to form a torque transmitting coupling therebetween that maintains concentricity between said hub and said rim liner while allowing said rim liner to grow radially with respect to said hub; and

an annular flywheel rim on said rim liner having an axis of rotation coinciding with said rim liner axis of rotation, and having a circumferential hoop direction.

2. A flywheel system as defined in claim 1, wherein:

said rim has a modulus of elasticity E_r in the hoop direction; and

said rim liner has a modulus of elasticity E_l in the hoop direction that is less than or equal to said rim modulus of elasticity E_r.

3. A flywheel system as defined in claim 1, wherein:

said flywheel rim liner has a hoop modulus of elasticity E_l, and a density ρ_l, and a liner ratio R_l equal to E_l/ρ_l;

said flywheel rim has a modulus of elasticity e_r in said hoop direction and a density ρ_r; and a rim ratio R_r equal to E_r/ρ_r

wherein R_l is less than or equal to R_r, so said flywheel rim liner grows radially with said rim.

4. A flywheel system as defined in claim 3, wherein:

said rim liner is a polyvinyl chloride tube.

5. A flywheel system as defined in claim 1, wherein:

said projections in said rim liner are pins set in said rim liner.

6. A flywheel system as defined in claim 1, wherein:

said projections in said rim liner are splines integral with said rim liner.

7. A hub for a high speed flywheel system, comprising:

a flywheel hub having radial splines;

a flywheel rim liner having radial projections mating with said splines to form a torque transmitting coupling between said hub and said liner that maintains concentricity between said hub and said rim liner;

said flywheel rim liner made of a material having a strain-to-failure capability and a ratio R_l equal to E_l/ρ_l, wherein E_l is a hoop modulus of elasticity of said rim liner and ρ_l is the density of said rim liner material;

said rim liner strain-to-failure capability and ratio R_l being such that said rim liner remains in compressive contact with said rim from start to maximum speed of said flywheel system.

8. A hub for a flywheel system as defined in claim 7, wherein:

said hub splines project radially outward and extend axially along the outside surface of said hub.

10. A process of coupling a flywheel rim to a flywheel hub, comprising:

mounting said rim on a rim liner; and

coupling said rim liner to said hub with a torque coupling that allows said liner to grow radially with respect to said hub while remaining concentric thereto during high speed operation.

11. A process as defined in claim 10, wherein:

said rim liner has a hoop modulus of elasticity E_l, and a density ρ_l, and a liner ratio R_l equal to E_l/ρ_l;

said flywheel rim has a modulus of elasticity E_r in said hoop direction and a density ρ_r; and a rim ratio R_r equal to E_r/ρ_r

wherein R_l is less than or equal to R_r, so said flywheel rim liner grows radially with said rim without detaching therefrom, and stays concentric to and torsionally engaged with said hub.

12. A process as defined in claim 10, wherein:

said coupling step includes engaging an array of radial projections spaced angularly around said liner in radial grooves in said hub.

13. A process as defined in claim 10, wherein:

said rim includes an inner annulus of E-glass/epoxy and an outer annulus of carbon fiber/epoxy having less material than said E-glass annulus;

whereby said carbon fiber/epoxy annulus is large enough to provide sufficient hoop strength to contain radial forces created in said rim by high speed rotation while allowing significant radial growth of said rim away from said hub, and said rim liner maintains torque coupling and concentricity of said rim and said hub during said operation despite said radial growth.

14. A process as defined in claim 13, wherein:

said rim liner has a strain-to-failure capability of greater than 4%.

15. A flywheel system, comprising:

a hub;

a flywheel rim concentric on said hub having a carbon fiber/epoxy outer annulus and, contiguous therewith, an E-glass inner annulus with an inner circumferential surface;

a rim liner engaged with said inner circumferential surface of said inner annulus;

said rim liner being made of a material that grows radially with said rim and has sufficient strength to transmit torque between said rim and said hub during flywheel spin-up and during energy recovery from said flywheel; and

a torque coupling between said hub and said rim liner that allows said liner to grow radially with respect to said hub while remaining concentric thereto during high speed operation.

16. A flywheel system as defined in claim 15, wherein:

said coupling includes an array of radial projections spaced angularly around said liner extending into radial grooves in said hub.

17. A flywheel system as defined in claim 16, wherein:

said radial projections constitute spline teeth projecting into corresponding spline grooves in said hub.

18. A flywheel system as defined in claim 17, wherein:

said spline teeth of said liner have a Poisson's Ratio which causes said teeth to be compressed under their own centrifugal loading as said rotor is spun to high speed, causing said teeth to become wider, thereby tightening the connection between the liner teeth and hub, to help keep the rotor stable.

19. A flywheel system as defined in claim 17, wherein:

said hub has a lower radially projecting lip to provide vertical support to said rim and rim liner

20. A flywheel system as defined in claim 15, wherein:

said rim liner has a hoop modulus of elasticity E_l, and a density ρ_l, and a liner ratio R_l equal to E_l/ρ_l;

said flywheel rim has a modulus of elasticity E_r in said hoop direction and a density ρ_r; and a rim ratio R_r equal to E_r/ρ_r

wherein R_l is less than or equal to R_r, so said flywheel rim liner grows radially with said rim without detaching therefrom, and stays concentric to and torsionally engaged with said hub.